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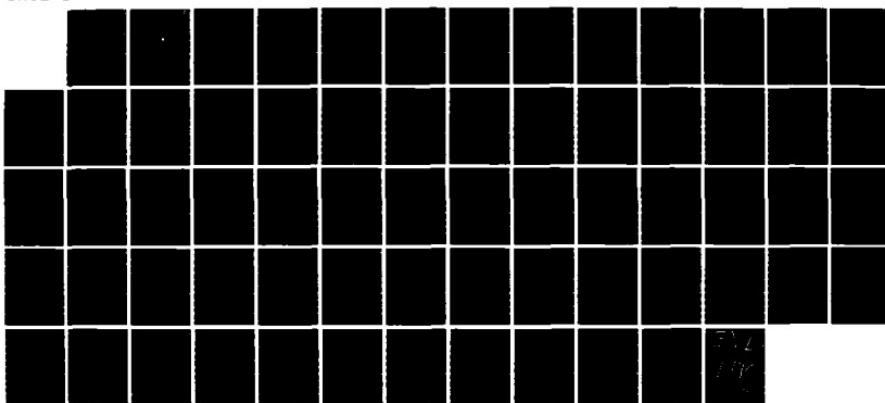
A SUMMARY OF THE FOUNDATION RESEARCH PROGRAM FISCAL
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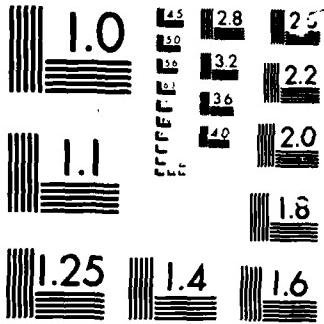
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NAVAL POSTGRADUATE SCHOOL

Monterey, California



A SUMMARY OF THE
FOUNDATION RESEARCH PROGRAM

May 1986

Report for the Period

1 October 1984 to 30 September 1985

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Prepared for:
Chief of Naval Research
Arlington, VA 22217

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NAVAL POSTGRADUATE SCHOOL
Monterey, CA 93943

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Thirty projects of Independent Research/Independent Exploratory Development were funded by the NPS Foundation Research Program. This research was in the areas of Computer Science, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical and Computer Engineering, Meteorology, Aeronautics, Oceanography, and Mechanical Engineering. A tabulation in the Appendix identifies the area of research and the investigator(s). The category of independent research or independent exploratory development is also identified for each research task.

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OVERVIEW OF THE NPS FOUNDATION RESEARCH PROGRAM FY 1985

The principal thrust of the research and exploratory development program at the Naval Postgraduate School (NPS) stems from its mission:

To conduct and direct advanced education of commissioned officers, and to provide such other technical and professional instruction as may be prescribed to meet the needs of the Naval Service; and in support of the foregoing to foster and encourage a program of research in order to sustain academic excellence.

A portion of the research performed at NPS is conducted through grants from the Chief of Naval Research. These funds provide the basis for the NPS Foundation Research Program reported here. Additional research sponsored by other sources as well is reported annually in A Summary of the Naval Postgraduate School Research Program.

A major goal of the Foundation Research Program is to strengthen the base of technology at NPS and to conduct research in areas of science and technology of interest to the Navy. Specific objectives include:

- * sponsoring research efforts of junior faculty enabling them to establish a strong research program in their chosen field.
- * allowing experienced faculty to change the course of their research programs.
- * providing the opportunity for the accomplishment of meritorious research projects that have no sponsor, and
- * increasing the general research capability of the Naval Postgraduate School through capital equipment procurement.

These objectives are pursued with the ultimate goal of stimulating the highest quality research program at NPS in support of the educational program received by students.

The Foundation Research Program is administered internally by a Research Council comprised of selected faculty members. The function of the Research Council is to properly implement the goals and objectives of the program with a view toward approving meritorious proposals submitted by the NPS faculty.

This report describes the accomplishments of the Foundation Research Program for FY 1985. The summaries of the research efforts are organized by academic departments. Some projects are oriented toward initiating and conducting scientific and applied research of a long-range nature in areas of special interest to the Navy. Other efforts are for conducting exploratory development deriving from scientific program areas of current Navy interest.

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**DEPARTMENT
OF
COMPUTER SCIENCE**

Title: Portable Software, Formal Semantics, and Limited Resource Systems

Investigator: D. Davis, Associate Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: To develop a methodology for describing computing resources abstractly, that is, independently of their implementation, as a framework for creating portable reusable computing resources.

Summary: This work is a continuation of work begun in the previous year. Last year, a theoretical framework was developed for describing computing resources abstractly, using techniques from the theory of abstract data types. During the past year, this framework has been used to guide the design and implementation of a number of abstract components of a typical computing system, as a test of the practical feasibility of the methodology we have developed. Specifically we designed and implemented an abstract processor. The unique characteristic of this processor's design is that its functional features, that is, "what" features it provides, are described independently of "how" these features are realized. In fact the first realization of this processor was written in software. The significance of this characteristic is that programs written to run on this abstract processor have the same portability properties as programs in a high level language. The only difference in realizations of the abstract processor is a difference in efficiency, there can be no difference in meaning or functionality. We feel this work is a forward step in solving the problem of portability, since it provides a means for defining and implementing resources in a pure form. Currently, computing resources are designed and implemented as a complex mixture of "what" we wish to have abstractly with "how" we can realize it.

Publications:

- D. Davis, "A Formal Method for Specifying Computer Resources in an Implementation Independent Manner," NPS Technical Report, NPS52-84-022, December 1984.
- D. Davis and J. Yurchak, "The Specification, Design and Implementation of an Abstract Processor," forthcoming.

- Conference Presentation: D. Davis, "Resource Abstraction and Validation," Verkshop III Conference on Verification, Pajaro Dunes, February 1985.
- Theses Directed: J. M. Yurchak, "The Formal Specification of an Abstract Machine: Design and Implementation," Master's Thesis, December 1984.
- R. Griffin, "An Algorithm to Test for Confluence in a System of Left to Right Rewrite Rules," Master's Thesis, December 1984.
- N. Lilly, "An Algebraic Specification Language and A Syntax Directed Editor," Master's Thesis, December 1984.
- J. E. Hunter, "The Formal Specification of a Visual Display Device: Design and Implementation," Master's Thesis, June 1985.
- U. Ozkan, "A Survey of Properties of Relations Which Have the Confluence Property," Master's Thesis, June 1985.

Title: Inferences Between Statistics on a Database

Investigator: N.C. Rowe, Associate Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: Formulation of relationships between different kinds of statistics on a finite data universe, in particular bounds on statistics, and the testing of results and the value of results by computer simulations and other experiments.

Summary: Appropriate computer science methods for reasoning about already-calculated statistics on a database were explored in two areas: (1) regression models, where an application of the artificial-intelligence concept of "inheritance" was formulated, and (2) bounds on set-intersection and set-union sizes, where a new and comprehensive theory of bounding methods was developed. The former problem is important in statistical analysis of large databases, and the latter is important in database query language design.

Publications:

N.C. Rowe, "Antisampling for Estimation: An Overview," IEEE Transactions on Software Engineering, SE-11, 10 (October 1985), 1081-1091.

N.C. Rowe, "Inheritance of Regression Models," NPS Technical Report NPS52-85-013, Computer Science Department, September 1985.

N.C. Rowe, "Absolute Bounds on Set Intersection and Union Sizes from Distribution Information," NPS Technical Report NPS52-85-014, Computer Science Department, September 1985.

Title: The Effects of Real-Time Display Generation on the Architecture of Graphics Display Systems

Investigator: M. J. Zyda, Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: The effects of special purpose VLSI architectures on the design of the graphics display system will be evaluated, with special attention to data input/output rates, human interaction, and currently available graphics display system functionality. Several graphics algorithms that have the potential for VLSI implementation will be identified and studied, with the goal being a characterization of the changes necessary in the architecture of the graphics display system required by VLSI based, real-time display generators.

Summary: The research quarters covered by this proposal are 1 January 1985 to 31 March 1985, and 1 July 1985 to 30 September 1985. The following work has been carried out:

The first objective of the study was to examine the proposed architecture of one real-time display generator, the contour surface display generator (Zyda, 1984a). Part of this objective has been carried out in the form of four technical memoranda (Zyda, 1984b), (Zyda, 1985a), (Walker, 1985a), and (Walker, 1985b). The first of these memoranda examined the feasibility of producing a real-time contour surface display generator. The second, third and fourth memoranda were studies of the architecture of the contour surface display generator, and its intended application. Part of these studies was the development of a modeling methodology for evaluating the physical parameters inherent to both the application, and the architecture.

The second objective of the study was to examine the input and output parameters obtained from the system model in order to determine exactly how that display generator can be interfaced to a graphics display system. This study was carried out in (Walker, 1985a) and (Walker, 1985b).

The third objective of the study was the identification of other graphics algorithms with the potential

for implementation in VLSI. This work has begun through the efforts of several current thesis students (see list below). The studies being carried out are cursory examinations of these algorithms for their distributability among multiple processors. Part of these studies will be an attempt to determine if the changes proposed for the graphics system for the contour surface display generator are applicable to other real-time display generators.

- Publications:
- M. J. Zyda, "Workstation Graphics Capabilities for the 1990's and Beyond," NPS Technical Report, NPS52-85-012, September 1985
- R. A. Walker and M. J. Zyda, "A Systems Architecture for Real-Time Contour Surface Display Generation," NPS Technical Report, NPS52-85-012, August 1985.
- R. A. Walker and M. J. Zyda, "An Integrated Systems Architecture for Real-Time Contour Surface Display Generation," NPS Technical Report, NPS52-85-010, August 1985.
- M. J. Zyda, "The Use of VLSI Technology for the Real-Time Generation of Graphics Displays: A Proposal," NPS Technical Report, NPS52-85-002, March 1985.
- M. J. Zyda, "The Feasibility of a Multiprocessor for Real-Time Contour Surface Display Generation," NPS Technical Report, NPS52-84-025, December 1984.
- M. J. Zyda, Algorithm Directed Architectures for Real-Time Surface Display Generation, D. Sc. Dissertation, 1984.
- Conference Presentation:
- M. J. Zyda, "Engineering Workstations: Graphics Capabilities for the 1990's and Beyond," Engineering Workstations Conference, Institute for Graphic Communication, February 3, 4, and 5, 1985.
- M. J. Zyda, "The Use of VLSI Technology for the Real-Time Generation of Graphics Display," Naval Air-Weapony Signal Processing Research Workshop, December 13 and 14, 1984.
- Theses Directed:
- M. Sahinteppe, "A Graph Theoretic Algorithm for Contour Surface Display Generation," Master's Thesis, June 1985.

R. A. Walker, "An Integrated Systems Architecture for Real-Time Contour Surface Display Generation," Master's Thesis, June 1985.

M. E. Gaddis, "The Fractal Geometry of Nature: Its Mathematical Basis and Application to Computer Graphics," Master's Thesis, December 1985.

K. Coomes, "Ray Tracing Algorithms in Computer Graphics Applications: Comparisons and Implementations," Master's Thesis, March 1986.

P. Hogan, "Surface Construction via the Triangulation of Contour Slices," Master's Thesis, December 1985.

S. Mungsing, "A Software Implementation of an Interactive System for Three-Dimensional Modeling and Layout," Master's Thesis, March 1986.

A. Jones, "Surface Construction via the Triangulation of Contour Slices: User Interaction Techniques," Master's Thesis, June 1986.

P. Collins, "Fractal Geometry and Its Application to Computer Graphics," Master's Thesis, June 1987.

**DEPARTMENT
OF
ADMINISTRATIVE SCIENCES**

Title: Group Decision Support System: An Advisory System for Bargaining and Negotiation

Investigator: T. X. Bui, Assistant Professor of Information Systems

Sponsor: NPS Foundation Research Program

Objective: To develop algorithms for supporting group decision making and negotiation, and implement them in a computer-based decision support system for geographically dispersed players.

Summary: A consensus seeking algorithm for group decision support system--the Negotiable Alternatives Identifier (NAI)--was developed which can be used together with the techniques of aggregation of preferences. Departing from individual and cardinal rankings of alternatives, NAI uses differential techniques to group ranked alternatives into three classes of preferences: the most preferred, the preferred and the least preferred sets of alternatives. Within each class, infinitesimal differences in preferences between alternatives make it more confident for the decision makers to trade them. As a result, a collective decision that may not be necessarily unanimous, yet essentially acceptable by all can be suggested.

The developed algorithm was implemented on an IBM-PC XT and interfaced with Co-op, a Decision Support System (DSS) for cooperative multiple criteria group decision making. Early tests performed with students in a DSS class showed encouraging results.

Publications: T. X. Bui, "NAI: A Consensus Seeking Algorithm for Group Decision Support System," Proceedings of the IEEE International Conference of Man, Systems, and Cybernetics, 11-16 November 1985, Tucson, Arizona.

M. Jarke, T. X. Bui and T. Jelassi, "Micro-Mainframe DSS for Remote Multiperson Decisions," in M. Jarke, Managers, Micros and Mainframes, Chichester, England, John Wiley and Sons, to appear, 1986.

Conference Presentation: T. X. Bui, "Bargaining and Negotiation Issues in Group Decision Support Systems," NYU-University of Paris Dauphine IX, Workshop on Group Decision Support System, January 1985.

Title: High Performing Systems in the Military: Defining Excellence in the Operational Forces

Investigators: R. T. Harris, Associate Professor of Management and R. A. McGonigal, Associate Professor of Management

Sponsor: NPS Foundation Research Program
Naval Military Personnel Command (NMPC-6)

Objective: To identify and describe the salient attributes of high performing military organizations and to determine the consensus views held by senior leaders within the military of what contributes to "excellence" in military organizations.

Summary: Patterned after the bestseller, In Search of Excellence: Lessons from America's Best Run Companies, this major research project involves the examination and description of high performing military organizations. A series of studies have been undertaken, each focused on a different military community and each aimed at locating and describing excellence within that military community. Seven studies are completed. Three of the reports have received widespread positive visibility within their respective communities. Three more studies are currently in progress. The ten studies include: Navy surface ships, Navy fighter and attack squadrons, Navy hospitals, Navy operational staffs, Army combat arms battalions, Air Force fighter squadrons, and Marine Corp battalions and air squadrons. Generally, each study is conducted as a graduate thesis project involving one or more students from the communities/service being studied. The transcripts of interviews conducted will be compiled and reported in a series of NPS technical reports.

Publication: G. G. Gullickson, R. D. Chenette and R. T. Harris, "Excellence in the Surface Navy," NPS Technical Report, NPS54-84-026, October 1984.

Conference Presentations: R. T. Harris, "Excellence and High Performance in the Military," Organizational Studies Symposium, Stockholm School of Economics, Stockholm, Sweden, 16 November 1984.
R. T. Harris, "Excellence and Change in Bureaucratic Organizations," University Associates Human Resource Development 1985 Conference, San Francisco, 28-29 March 1985.

- Title: J. Simonsen, D. Hoopengardner and H. Frandsen,
"Excellence in the Combat Arms," Master's Thesis,
December 1984.
- S. Sigler, "Excellence in the VP Navy," Master's Thesis, December 1984.
- J. Norton, "Excellence in Navy Health Care,"
Master's Thesis, December 1984.
- M. Pierce and R. Porter, "Excellence in the Surface
Coast Guard," Master's Thesis, December 1984.
- H. Forde, "Excellence in Tactical Fighter Squadrons,"
Master's Thesis, June 1985.
- H. Coffman, "Essence of Excellence: Lessons from
Naval Executives about Superior Performing Tactical
and Readiness Staffs," Master's Thesis, June 1985.

Title: Task Definition, Decision-Criteria and Uncertainty Reduction: The Role of the Agency Budget Office

Investigator: J. L. McCaffery, Professor of Public Budgeting, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To explore the behavior of budget offices with the intention of developing stable sets of inventories applied to budget decision-making. This is an on-going project focused on the Department of Navy Budget Office and the Department of Defense Planning-Programming-Budgeting system with comparisons made to other budget offices and processes.

SUMMARY: During this reporting period background research on issues impacting on budget office routines has led to an assessment of various phases of contemporary budget reforms. This paper will be published in the International Review of Public Administration, under the title "The Road to Reform of Process" in January 1986.

A second paper focused on the executive budget process comparing routines in Canada and in California to see what sets of behavior were stable across very different institutional settings. This paper was presented at a symposium at the University of California, Berkeley. A revised version of this paper is under consideration by the Policy Studies Journal.

Two further presentations extending this research are scheduled for this year, one on comparative budget systems at the Western Social Science Association in April 1986 and one on organizational strategies for increasing productivity at the Western Political Science Association in March 1986.

Publications: J. L. McCaffery, "The Road to Reform of Process," International Journal of Public Administration, forthcoming.

J. L. McCaffery, "Crossing Cultural Boundaries - Two Budget Systems," Policy Studies Journal, in review.

Conference Presentations: J. L. McCaffery, "Comparison of State and Provincial Budget Systems with Ontario and California Used as Models," Workshop on Comparative Canada/U.S. Public Policy, University of California, Berkeley, 22-23 April 1985.

Title: An Evaluation of Leasing as a Financing Strategy Within the Navy

Investigator: J. G. San Miguel, Professor of Accounting

Sponsor: NPS Foundation Research Program

Objective: The aim of this research was to evaluate the cost effectiveness of leasing as an alternative financing strategy for the Department of the Navy specifically, and the Department of Defense generally. This evaluation of the efficacy of leasing was twofold: first, from the point of view of DON in achieving its overall objectives for the program for which the equipment was leased, and second, from the view of the overall operation of the U.S. government.

Summary: Recently both the Department of the Navy and the Department of Defense initiated plans to lease capital equipment as opposed to the use of appropriated funds to purchase capital equipment. Congress, the General Accounting Office, and the public have expressed concern on this initiative. Although usually far more complex, most leasing arrangements between an owner of capital equipment and someone who wishes to use the capital equipment are viewed as a "rental" arrangement. The DON's lease arrangements for thirteen ships for its Military Sealift Command are long-term contracts for "transportation services." The length of lease and renewable options, tax benefits, cancellation provisions (DON guarantees for legal fees and lost interest) involved in the agreements are extremely more complex. An exhaustive study of the extant literature was completed and numerous personal interviews conducted with individuals within DON and others knowledgeable in leasing and the shipbuilding industry.

Thesis Directed: R. E. Ratcliff, "A Framework for the Procurement of Assets Through Leasing Arrangements," Master's Thesis, December 1984.

Title: **Coupling Symbolic Reasoning and Numerical Computing Systems**

Investigator: **T. R. Sivasankaran, Assistant Professor of Management Information Systems**

Sponsor: **NPS Foundation Research Program**

Objective: **Modeling and designing symbolic-numeric interfaces for an expert system. The long-term objectives include development of methods to integrate various technologies like expert systems, decision support systems, data base management systems and other operational systems into a single organizational computer system.**

Summary: **The period covered by the sponsor was only two months. This time was spent in reviewing literature related to the research topic and developing a first-cut conceptual model for coupling the symbolic planning and numerical execution in an expert system in the domain of actuarial science.**

Publication: **T. R. Sivasankaran and M. Jarke, "Coupling Expert Systems and Actuarial Pricing Models," Proceedings of the Workshop on Coupling Symbolic and Numerical Computing in Expert-Systems, Bellevue, Washington, August 1985. To be included in forthcoming publication by North-Holland Publishing Company.**

Conference Presentation: **T. R. Sivasankaran and M. Jarke, "Coupling Expert Systems and Actuarial Pricing Models," Workshop on Coupling Symbolic and Numerical Computing in Expert Systems, Bellevue, Washington, August 1985.**

Title: Application of Spreadsheet Programs to Manpower Modeling

Investigator: T.G. Swenson, Assistant Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To demonstrate the utility of spreadsheet programs as decision aids in the manpower, personnel and training areas of study.

Summary: The project resulted in the identification and demonstration of a wide variety of spreadsheet applications to Manpower, Personnel and Training areas such as: 1) Trend analysis, 2) Manpower Planning, 3) Markov analysis, 4) Economic analysis of training, 5) Compensation analysis, 6) Selection and Recruiting evaluation, 7) Promotion Planning, 8) Utility analysis, and 9) Productivity analysis.

Theses Directed:

H.T. Styron, "The Application of Microcomputer Spreadsheets to Produce the U.S. Army Five Year Field Grade Officer Promotion Plan," Master's Thesis, Dec. 1984.

G.T. McCannel, "A Cost Determination Model for the Functional Context Training Revision of Basic Electricity and Electronics Training," Master's Thesis, Dec. 1985.

P.R. Stahl, "In Search of Combat Readiness in the U.S. Marine Corps," Master's Thesis, Dec. 1985.

Title: Use of the Rasch Model in Sequential Testing

Investigator: R. A. Weitzman, Associate Professor of Psychology

Sponsor: NPS Foundation Research Program

Objective: To improve the efficiency and the applicability of sequential testing for selection of school or job applicants through the use of the Rasch item-response model.

Summary: Sequential testing for selection requires estimation of the proportion of examinees in each test-score group who get an item right. The Rasch model provides such an estimate. This research has developed the procedure and is in the process of applying it to the real data and preparing a report of the results.

Publication: R. A. Weitzman, "The Rasch Model Plus Guessing," in progress. Will be submitted to the Journal of Applied Psychology for possible publication.

**DEPARTMENT
OF
OPERATIONS RESEARCH**

Title: A Study of the Projective Algorithm for Linear Programming

Investigator(s): G. G. Brown, Professor of Operations Research and R. K. Wood, Assistant Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To develop and analyze a prototypic projective linear programming algorithm

Summary: This work has been conducted jointly with Professor R. D. McBride at the University of Southern California. A algorithmic barrier function variant of the projective linear programming algorithm has been implemented and tested. Testing on medium - scale problems has verified controversial claims of low iteration counts. However, total solution times are long since solution of the symmetric linear system of equations at each iteration is difficult. Current research efforts are directed at speeding up these solutions using an incomplete Cholesky factorization with iterative improvements.

Publications: None

Conference Presentations: R. K. Wood, "Implementing the Projective Linear Programming Algorithm ", ORSA/TIMS Joint National Meeting, Boston, Massachusetts, April 29 -May 1, 1985.

G. G. Brown, R. D. McBride and R. K. Wood, "Computational Methods in the Projective Linear Programming Algorithm, "ORSA/TIMS Joint National Meeting, Atlanta, Georgia November 4-6, 1985.

Thesis Directed: G. W. Bretschneider, "An Implementation of The Projective Algorithm for Linear Programming," Master's Thesis, September 1985

Title: An Approximate Solution Technique for the Constrained Search Path Moving Target Search Problem

Investigator(s): J. N. Eagle, Associate Professor of Operations Research
J. R. Yee, Adjunct Professor of Operations Research

Sponsor: NPS Research Foundation Program (for J. N. Eagle only)

Objective: To develop an easily implemented approximate solution procedure for the constrained search path moving target search problem.

Summary: A search is conducted for a target moving in discrete time among a finite number of cells according to a known Markov process. The searcher must choose one cell in which to search in each time period. The set of cells from which he can choose is a function of the cell chosen in the previous time period. The problem is to find a searcher path, i.e., a sequence of search cells, that minimizes the probability of not detecting the target in a fixed number of time periods. The problem is formulated as a nonlinear program and solved for a local optimum by a simple implementation of the convex simplex method.

Publications: J. N. Eagle and J. R. Yee, "An Approximate Solution Technique for the Constrained Search Path Moving Target Search Problem," NPS Technical Report NPS55-85-015, October 1985.

Conference Presentations: None

Thesis Directed: M. Segal, "Two New Approximate Solution Techniques for a Moving Target Problem when Searcher Motion is Constrained", Master's Thesis, September 1985

Title: Multicommodity Network Flow Optimization

Investigator(s): R. E. Rosenthal, Associate Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To develop efficient solution methodology for very large scale multicommodity network optimization problems.

Summary: Multicommodity network flow optimization has long been identified as an important problem area in civilian and military logistics applications. An algorithm developed by the investigator has achieved approximate solutions on some to the largest problems of this type ever attempted. These problems were based on data supplied by the Army Armament, Munitions and Chemical Command.

Publications: None

Conference Presentations: None

Thesis Directed: None

**DEPARTMENT
OF
NATIONAL SECURITY AFFAIRS**

Title: Soviet-American Conceptual Modeling

Investigator: Robert B. Bathurst, Adjunct Professor, National Security Affairs

Sponsor: NPS Foundation Research Program

Objective: To develop and test a method for uncovering and teaching differences in reasoning, value systems and patterns of behavior between roughly socially equivalent groups of Americans and Soviets.

Summary: The project was successful in perfecting and in demonstrating a method for revealing and studying unconscious cultural barriers to international understanding. With the help of the research funds, a major colloquim was held with participant experts of international standing. Following, with the aid of the grant, two workshop-laboratories were held with internationally known ex-Soviet experts participating. The result was the creation of a format for seminars and laboratories to educate Americans involved in diplomacy, education or business in patterns of behavior which they can expect from Soviet counterparts as well as in patterns of behavior which they can expect among their own colleagues. The method is now being applied in Washington, D.C., where sessions are being organized for training high-level government officials. Plans are under way for further demonstrations and sessions in New York and Florida. The method appears adaptable for many situations and groups.

Publications: "On Soviet Linguistics: Expropriating Utopia," an article directly related to the results of this study is being published in a book entitled, Soviet Deception, edited by Brian Dailey and Patrick Parker, to be published in the fall of this year. An article about the games appeared in Community Spirit, October 1985, written by Pamela Benda. Other materials and articles will be forthcoming.

Title: Soviet Involvement in Caribbean

Investigators: R. Looney, Associate Professor of National Security Affairs, and J. Valenta, Associate Professor of National Security Affairs

Sponsor: Naval Postgraduate School Foundation

Objective: Determine to the extent possible, conditions surrounding Soviet involvement in the Caribbean.

Summary: Found it was possible to profile the environment surrounding Soviet involvement in the Caribbean. Discriminant analysis profile of countries where the Soviet Union was involved differed significantly from those countries where Soviet involvement was not present.

**DEPARTMENT
OF
PHYSICS**

Title: Radiation Effects on Infrared Materials and Devices

Investigator: K.C. Dimiduk, Assistant Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To study the effects of electron irradiation on infrared semiconductor materials and devices.

Summary: The effect of radiation damage due to 30 MeV electrons on bulk semiconductors and certain devices was studied. The bulk material experiments were conducted on mercury cadmium telluride, used to make infrared detectors, and the related substrate material cadmium telluride. Wafers were cooled to approximately 100K and irradiated to fluences of 10^{13} e/cm² to 6×10^{15} e/cm². Measurements of conductivity or resistivity, mobility and carrier concentration at various temperatures were used to assess the effect of the irradiations.

The devices chosen for study were emitters and detectors used for fiber optic systems. Preliminary measurements were made on long wavelength (1.3 micron) InGaAsP LEDs and InGaAs photodiodes. From this it was determined that additional work was needed to establish a measurement technique. That was done using shorter wavelength GaAsP LEDs since they were considerably cheaper. These LEDs turned out to be significantly softer than earlier LEDs reported in the literature, indicating that the GaAsP work was important to pursue. Currently, additional 1.3 micron devices of the original composition are being studied using the techniques developed on this project under an outside supported follow-on project.

Publications: K.C. Dimiduk, C.Q. Ness and J.K. Foley, "Electron Irradiation of GaAsP LEDs," Transactions on Nuclear Science, Volume NS-32, Number 6, pp. 4010-4015, December 1985.

Conference Presentations: K.C. Dimiduk, C.Q. Ness, and J.K. Foley, "Electron Irradiation of GaAsP LEDs," 1985 Annual Conference on Nuclear and Space Radiation Effects, Monterey, CA, July 1985.

Theses Directed: C.Q. Ness, "Electron Irradiation of Light Emitting Diodes," Master's Thesis, December 1984.

C.P. Bauer, "Electron Irradiation of n-Type Cadmium Telluride," Master's Thesis, March 1985.

D.G. Morral, "Electron Irradiation of p-Type Mercury Cadmium Telluride," Master's Thesis, June 1985.

Theses Directed
(cont.):

J.K. Foley, "30MeV Electron Beam Irradiation Effects
on GaAsP LEDs, " Master's Thesis, June 1985.

TITLE: The Interaction of Electromagnetic Waves with Periodically Rough Surfaces on Conductors

INVESTIGATOR: N. E. Glass, Adjunct Teaching Professor

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To develop mathematical tools to analyze the interaction of electromagnetic waves with rough conducting surfaces, for the purpose of studying resonant absorption and field enhancement at such surfaces. To study, theoretically, Smith-Purcell radiation from electron beams above grating surfaces, for the purpose of generating soft x-rays.

SUMMARY: An exact theory of the scattering of electromagnetic waves, with resonant excitation of surface-polaritons, from conducting bigrating surfaces was numerically fit to the results of recent experiments, and was then compared to the predictions of a standard perturbation theory. Many of the discrepancies between the experiment and perturbation theory were narrowed or eliminated by the exact theory. The perturbation theory's degree of error in predicting the surface profile was determined. A new perturbation theory was derived analytically, which permits the calculation of the scattering intensity, through a 4x4 matrix equation, at points corresponding to 2-polariton excitations (around mini-gaps in the surface-polariton dispersion relation). An exact expression for the intensity of Smith-Purcell radiation from electrons travelling above a bigrating surface, of finite conductivity, was also developed. This is the first such calculation which permits the electron beam to have an arbitrary orientation parallel to the surface and the first to consider a doubly periodically corrugated surface. The result is a set of interference terms not seen in the case of a classical grating. This work will allow one to determine the extra enhancement in the radiated intensity due to the simultaneous resonant excitation of two surface-polaritons.

PUBLICATION: N. E. Glass and A. A. Maradudin, "Polariton Resonant Absorption in a Bigrating" Exact Theory Compared to Recent Experiments and to Perturbation Theory," Optics Communications, accepted for publication.

CONFERENCE
PRESENTATION:

The results of this research will be given in an invited-review-paper, to be presented by A. A. Maradudin, at the forthcoming International Laser Science Conference in Dallas, TX 18-22 Nov 1985.

TITLE: The Pumping of Photochemical Species in the Middle Atmosphere by Acoustic-Gravity Waves

INVESTIGATORS: Steven F. Nerney, Associate Professor of Physics and G. W. Adams, Senior Research Professor of Physics at Utah State University.

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To purchase an office-based computer system compatible with those used at USU in conjunction with the HF radar program as well as the photochemical modelling program at USU.

SUMMARY: The AT&T PC 6300, Bernoulli Box, Micom Modem and Epson printer are all installed in my office. Preliminary work has been done on photochemical pumping of minor species by passing gravity waves. The concentrations of minor species have been plotted as a function of time based on a simple computational scheme which solves the differential equations for those concentrations. We are just beginning this study.

CONFERENCE PRESENTATIONS: "Modelling Mesospheric Chemical Pumping Due to Temperature Variations," R. A. Armstrong, S. F. Nerney, and G. W. Adams was presented by Dr. Armstrong at the spring meeting of the American Geophysical Union.

**DEPARTMENT
OF
ELECTRICAL AND
COMPUTER ENGINEERING**

TITLE: Ultra-An Ultra-Reliable Real Time Processor

INVESTIGATOR: Larry Abbott, Assistant Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: The research is a continuation of research into an integrated approach to system fault tolerance. The approach optimizes the system reliability by simultaneously satisfying hardware and software reliability requirements.

SUMMARY: In this reporting period we have completed the preliminary design of the fault tolerant computer and real time operating system. We have completed the detailed design of the fault tolerant voter and rotary multiplexer. A VLSI design of the rotary multiplexer has been done. We have also begun the development of reliability assessment tools for evaluating the analysis of fault tolerant techniques for implementing the fault tolerant computer in VLSI.

CONFERENCE PRESENTATION: L. W. Abbott, "A Synergistic Fault Tolerant Computer Design for an N-Version Programming Environment", Nineteenth Annual Asilomar Conference on Circuits, Systems, and Computers, Pacific Grove, California, November 6-8, 1985.

TITLE: VLSI Circuit Design - A Silicon Compiler Approach

INVESTIGATORS: D. E. Kirk, Professor of Electrical and Computer Engineering, H. H. Loomis, Jr. Adjunct Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To utilize the MacPitts silicon compiler to investigate architectural alternatives for signal processing operations, including making comparisons between the circuits generated and those obtained by a hand-crafted approach, and to enhance the capabilities of MacPitts.

SUMMARY: Four designs have been completed, two designs of a 16-bit pipeline adder and two designs of a pipelined multiplier (one 8-bit and one 16-bit). Two of these designs were obtained by a custom approach using computer-aided design tools whereas the other two designs were obtained by using MacPitts. Comparisons indicate that the MacPitts designs are somewhat slower, and less dense, but not so much as to make this approach infeasible. As a result of these comparisons, several areas for improvement have been indicated and efforts are continuing to implement appropriate modifications.

PUBLICATION: VLSI Design Using a Silicon Compiler Approach, D. E. Kirk and H. H. Loomis, Jr. NPS Technical Report, in progress.

THESES DIRECTED: Silicon Compiler Design of Combinational and Pipeline Adder Integrated Circuits, MSEE Thesis, A. N. Fioede III, June 1985.

VLSI Design with the MacPitts Silicon Compiler/R. C. Larrabee, MSEE Thesis, Sept. 1985.

VLSI Design of a Sixteen Bit Pipelined Multiplier Using Three Micron NMOS Technology, MSEE Thesis, R.J. Simchik, Jr., June 1985.

TITLE: Inherent Tracking Errors of a Monopulse Radar

INVESTIGATOR: Hung-Mou Lee, Assistant Professor of Electrical
and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To study the inherent angular tracking errors of monopulse radars and to develop, based on the findings of this study, countermeasures against this type of radar.

SUMMARY: A radar is designed for tracking a point target but is always used for tracking a complex target. This will result in errors in the estimated target location by the radar. This type of error has been discussed over the previous 25 years without its origin being recognized. Related problems have been over-simplified and journal publications have been infested with erroneous claims. This research is intended to point out the inadequacies in previous work and to lay the foundation for future developments in this area.

THESES DIRECTED: Dae Hyun Park, "Inherent Tracking Error in an Amplitude Comparison Monopulse Radar," Master's Thesis, December 1984.

Sopon Bumroongpol, "Angular Tracking Error in a Phase Comparison Monopulse Radar: A Critical Review and Extension of the Phase Front Distortion Approach," Master's Thesis, December 1994

TITLE: High-Speed, High-Accuracy Integrated Operational Amplifiers

Investigator: Sherif Michael, Assistant Professor of Electrical and Computer Engineering

Sponsor: Foundation Research Activity

Objective: To develop high-speed, high-accuracy integrated operational amplifiers using the composite operational amplifier techniques previously proposed by the researcher. One major goal of the research was to develop a micro and a macro-computer-model of the different operational amplifiers to be used in designing and evaluating the new composite amplifier.

Summary: An intensive survey of currently available state-of-the-art technology for designing fast, accurate operational amplifiers (op amps) was completed. Based on the result of that survey, it was found that using the composite amplifier approach would yield the best results. The research examines and discusses the feasibility of utilizing composite op amps to overcome the inherent inability of the IC op amps to simultaneously perform in a very fast, very accurate mode. The novel designs developed were also found to provide enhanced stability, decreased sensitivity to circuit element variations and significant extension in bandwidth. Computer simulations of the constructed op amps using the two developed micro and macro models were found to be agreeable to the extensive experimental results. Results in both linear and non-linear applications were demonstrated. These optimum novel designs not only offer significantly improved AC and DC performance over currently available devices, but also make no new demands on technology, since they only require the devices that can be produced with currently available linear monolithic techniques.

Publications: S. Michael and P. Gariano, "Micro and Macromodeling of Integrated Operational Amplifiers and Their Use in Developing and Evaluating New Composite Op Amps," Proceedings of Midwest Symposium on Circuits and Systems, Louisville, KY., August 1985.

S. Michael and P. Gariano, "Optimization of High-Speed, High-Accuracy Integrated Operational Amplifiers," Proceedings of Midwest Symposium on Circuits and Systems, Louisville, KY., August 1985.

S. Michael and P. Gariano, "Application of Precision, High-Slew Rate Op Amps in Active Networks," Proceedings of Midwest Symposium on Circuits and Systems, Louisville, KY, August 1985.

Conference Presentation:

S. Michael, "Micro and Macromodeling of Integrated Operational Amplifiers and Their Use in Developing and Evaluating New Composite Op Amps," Midwest Symposium on Circuits and Systems, Louisville, KY, Auguat 1985.

S. Michael, "Application of Precision, High-Slew Rate Op Amps in Active Networks," Midwest Symposium on Circuits and Systems, Louisville, KY, August 1985.

Theses Directed:

A. Luczak, "Composite Operational Amplifiers and Their Use in Improving Bandwidth, Speed and Accuracy in Active Networks," Master's Thesis, June 1985.

P. Gariano Jr., "Generation of an Optimum High Speed, High Accuracy Operational Amplifier," Master's Thesis, September 1985.

TITLE: Vector-Valued Image Processing

INVESTIGATOR: C. W. Therrien, Associate Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To explore the use of multichannel signal models for the analysis of color images and other multiple frequency band sets of images.

SUMMARY: Work was begun on developing multichannel two dimensional (2-D) signal models for images. The research focused on linear predictive (all-pole) models. Several important relations linking multichannel images to other multidimensional signals were discovered. An algorithm based on the models to segment color images was developed. Work was begun on multichannel 2-D spectral estimation. This work seeks to develop model-based high resolution methods for the estimation of spectra and cross spectra in 2-D

PUBLICATION: C. W. Therrien, "Multichannel Filtering Methods for Color Image Segmentation," Proc. IEEE Comp. Soc. Conf. on Computer Vision and Pattern Recognition, 19-23 July 1985, San Francisco

**DEPARTMENT
OF
METEOROLOGY**

Title: Satellite Remote Sensing of Marine Atmospheric Boundary Layer (MABL) Characteristics

Investigator: P. A. Durkee

Sponsor: NPS Foundation Research Program

Objective: This was the first of a multi-year effort to investigate remote sensing techniques applicable to the marine atmospheric boundary layer.

Summary: This year's effort was devoted to implementing software for data analysis and radiative transfer routines. The investigation emphasized the effects of particles above the MABL, variable wind speed, and MABL depth. A technique to detect particles above the MABL was developed and tested. This technique uses dual-wavelength, satellite-detected, radiance measurements to estimate variations in the slope of the aerosol particle size distribution. Distributions of varying slope, in turn imply variations of particle type and origin.

Publications: P. A. Durkee, D. R. Jensen, E. E. Hindman and T. H. Vonder Haar, "The Relationship Between Marine Aerosol Particles and Satellite-Detected Radiance", Journal of Geophysical Research, forthcoming.
P. A. Durkee, "Aerosol Characteristics Inferred from Dual-Wavelength Radiance Measurements", Journal of Geophysical Research, in progress.

Conference Presentation: P. A. Durkee, "The Vertical Distribution of Marine Aerosols Inferred from Dual-Wavelength Radiance Measurements", Topical Meeting on Optical Remote Sensing of the Atmosphere, Optical Society of America, Incline Village, NV, 15-18 January 1985.
P. A. Durkee, E. E. Hindman and T. H. Vonder Haar, "Marine Boundary Layer Characterization from Satellite-Detected Aerosol Optical Depth", IAMAP/IAPSO Joint Assembly, Honolulu, HI, 5-16 August 1985.

Title: Investigation of the Structure and Evolution of the Coastal ABL using an Acoustic Doppler Sodar System

Investigator: W. J. Shaw

Sponsor: NPS Foundation Research Program

Objective: The objective of this work was to initiate surface-based remote sensing and high-resolution radiosonde data acquisition capabilities for the atmospheric boundary layer which will ultimately yield insight into: the relationship between inversion wind shear and ABL small-scale structure and entrainment energetics; ABL structure resulting from inhomogeneities of the coastal region; and the relationship between the structure of the coastal ABL and larger-scale weather systems.

Summary: The primary task in this effort was the calibration of the NPS sodar for the measurement of the acoustic refractive index structure parameter, C_T^2 . This was accomplished by two methods: (1) an *in situ* technique (described in deRouge's thesis) in which C_T^2 was generated from similarity theory of atmospheric surface layer turbulence and compared directly with system output and (2) NPS anechoic chamber measurements of the sodar antenna's near-field acoustic phase and amplitude distribution for a given input voltage. This two-dimensional distribution is then Fourier-transformed to obtain the antenna far-field gain pattern. Transducer efficiencies for acoustic/electrical conversion were measured using a calibrated microphone. This information provides the second calibration. Additional substantial effort was given to the revision of software for the Beukers W8000RP radiosonde system obtained through this funding. The system now works properly and reliably. Together the sodar and radiosonde systems now provide excellent quantitative measurements of the mean and turbulent structure of the ABL.

Thesis Directed: E. deRouge, "An Investigation of the Atmospheric Boundary Layer over the Arctic Ocean using Sodar". Master's Thesis, September 1985.

**DEPARTMENT
OF
AERONAUTICS**

Title: Metallized Fuel Ramjet Combustion

Investigators: A. Gany, NRC Postdoctoral Associate and
D. W. Netzer, Professor of Aeronautics

Sponsor: National Research Council/NPS Foundation Research Program

Objective: Conduct fundamental experimental and analytical studies to enhance the understanding of the combustion behavior of ramjets that utilize large mass fractions of metal within the solid fuel.

Summary: Thermochemical evaluation of fuel candidates for ramjet propulsion was made in terms of the theoretical heat of combustion per unit mass and per unit volume of the fuel. Compared with the commonly used hydrocarbons, the main advantage of using metals or metal compounds is their much higher energy density, which is of great significance in volume limited systems. For practical use, boron has the highest energy density of all elements (almost three times higher than that of hydrocarbons). However, several boron compounds exhibit similar theoretical performance, especially boron carbide and the high borides of aluminum, magnesium, and silicon.

Combustion phenomena of highly metallized, boron containing, solid fuels in solid fuel ramjets (SFRJ) were studied by means of high speed photography using a windowed two-dimensional SFRJ combustor. The experiments indicated the existence of a gas phase diffusion flame of the volatile fuel ingredients within the boundary layer above the fuel surface. It was also revealed that material is often emitted from the surface in the form of large pieces and segments. Flow impingement on the surface may cause surface heating and glowing by chemical reactions, which promote the high speed ejection of hot particles and the emittance and disintegration of large glowing segments and pieces from the fuel surface layer to the gas stream.

Publications:

A. Gan and D. W. Netzer, "Thermochemical Evaluation of Fuel Candidate, for Ramjet Propulsion", in Proceedings of the 27th Israel Conference on Aviation and Astronautics, pp. 210-219, February, 1985.

A. Gan and D. W. Netzer, "Combustion Studies of Metallized Fuels for Solid Fuel Ramjets", AIAA-85-1177, AIAA/SAE/ASME/ASEE 21st Joint Propulsion Conference, July 8-10, 1985.

A. Gan and D. W. Netzer, "Fuel Performance Evaluation for the Solid-Fueled Ramjet", NPS Report 67-84-012, October, 1984.

Conference

A. Gan and D. W. Netzer, "Thermochemical Evaluation of Fuel Candidate, for Ramjet Propulsion," 27th Israel Conference on Aviation and Astronautics, February 1985.

A. Gan and D. W. Netzer, "Combustion Studies of Metallized Fuels for Solid Fuel Ramjets," AIAA/SAE/ASME/ASEE 21st Joint Propulsion Conference, July 8-10, 1985.

Title: Composites Reliability Certification Methodology

Investigator(s): Edward M. Wu, Professor of Aeronautics and
S. H. Own, Research Professor of Aeronautics

Sponsor: Naval Air Systems Command
NPS Research Foundation

Objective: The objective of this program is to conduct coordinated experimental and analytical investigations which will provide test methods, data, and theories contributing to the rational development of certification methodology for fiber reinforced composites structures.

Summary: Application of fiber reinforced composites to gain performance improvement in advanced structures requires theory and materials data for design and for certification. We address the accept or reject process based on the expected composite strength and durability of the composite by quantifying the statistical strength and life of composite under uniaxial stress and under combined stress.

Specifically, this program includes treatment of:

(a) Uniaxial probabilistic strength and life including model identification, single fiber filament testing and single filament composite testing.

(b) Combined-stress probabilistic strength and life including theoretical modeling, experimental data generation and computer software implementation for applications.

Conference Presentation: S. H. Own, "A Statistical Formulation of Composite Strength Distribution: Fiber, Matrix, and Interface," Gordon Research Conference on Composites, Santa Barbara, CA, Jan. 13-17, 1986.

**DEPARTMENT
OF
OCEANOGRAPHY**

Title: The Tropical Oceanic Boundary Layer

Investigator: R.W. Garwood, Jr., Associate Professor of Oceanography

Sponsor: NPS Foundation Research Program

Objective: The objective of this project is to understand the role of the mixed layer in the dynamics of the tropical ocean. The main thrusts of this research are to develop (i) a numerical model and, (ii) climatological data base for model initialization and verification.

Summary: An oceanic model for tropical application has been developed to include the interaction of planetary rotation and Reynolds stress, and the thermodynamic/hydrodynamic effects of the absorption of solar radiation which penetrates the ocean surface. The steady-state version of this model has been tested in the equatorial Pacific Ocean, and should be an important contribution to the understanding of the role of turbulent mixing in the distribution of properties in the equatorial oceans. It has already explained the zonally asymmetrical distribution of mixed layer depth in the equatorial Pacific Ocean.

A data base for the climatological atmospheric forcing for the Atlantic Ocean has been assembled, enabling a test of the model in the tropical Atlantic. This test demonstrated the potential for the interaction of planetary rotation and Reynolds stresses to mediate the climatological mixed layer depth in the tropical Atlantic Ocean.

Publications: R.W. Garwood, Jr., P. Muller and P.C. Gallacher, "A Model for the Equilibrium Mixed-Layer Depth in the Equatorial Pacific," Tropical Ocean-Atmosphere Newsletter, Number 30, pp. 10-11, March 1985.

R.W. Garwood, Jr., P. Muller, and P.C. Gallacher, "Wind Direction and Equilibrium Mixed Layer Depth in the Tropical Pacific Ocean," Journal of Physical Oceanography, 15, pp. 1332-1338, October 1985.

Publications
(cont'd): R.W. Garwood, Jr., and P. Muller, "Modelling of the Equatorial Mixed Layer," submitted to Oceanological Data, 9 pp., 1985.

Conference
Presentation: P.C. Gallacher, R.W. Garwood, Jr., and P. Muller, "Wind Direction and Equilibrium Mixed Layer Depth: General Theory," IAMAP/IAPSO Joint Assembly, Honolulu, Hawaii, August 1985.

Thesis Directed: J.F.F.A. Gaspar, "The Equilibrium Mixed Layer Depth in the Tropical Atlantic: The Rotation Stress and Penetration of Radiation Effects," Master's Thesis, June 1985.

**DEPARTMENT
OF
MECHANICAL ENGINEERING**

Title: The Turbulent Boundary Layer: Small-Scale Structural Characteristics and Eddy Motions

Investigator: P. M. Ligrani, Associate Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: To study small-scale fluid motions in the near-wall portions of turbulent boundary layers.

Summary: Purchase of equipment and design of new facility to allow study of near-wall turbulent motions. Study of needed type of data acquisition system. Development and analysis of subminiature hot-wire sensors with spatial resolution.

Publication: P. M. Ligrani, "Subminiature Hot-Wire Sensor Construction," Naval Postgraduate School Technical Report, NPS69-84-010, November 1984.

Conference Presentation: P. M. Ligrani, "Subminiature Hot-Wire Sensors and Resolution of Small-Scale Turbulence," Fifth Symposium on Turbulent Shear Flows, Cornell University, New York, August 7-9, 1985.

Title: Optimal Control of Robotic Mechanisms

Investigator: D. L. Smith, Associate Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: To investigate the application of optimal control theory to the control of robotic mechanisms.

Summary: Computer-based controllers operating optimal control algorithms are capable of coordinating robotic motions in complex mechanisms. This work is aimed at identifying the research issues surrounding this type of control.

A table-top manipulator arm and a programmable controller were selected and purchased. A data acquisition system has been designed and is being installed. A nonlinear simulation of the arm, the hydraulics, and the rudimentary built-in controller has been developed. Test cases have been identified to validate simulations and optimal control logic.

Theses Directed: D. Lewis, "Modeling of Low-Speed Motion of Rigid, Revolute Mechanisms," Master's Thesis, December 1985.

W. McCarthy, "Simulation of High-Speed Motion of Rigid, Revolute Mechanisms," Master's Thesis, December 1985.

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